



AN ANTHROPOMETRIC STUDY ON THE COMPONENT BONES IN EGYPTIAN'S MALE AND FEMALE FOOT

Ibrahim Shaaban

Anatomy Department, Faculty of medicine, Mansoura University

Follow this and additional works at: <https://mmj.mans.edu.eg/home>

Recommended Citation

Shaaban, Ibrahim (2006) "AN ANTHROPOMETRIC STUDY ON THE COMPONENT BONES IN EGYPTIAN'S MALE AND FEMALE FOOT," *Mansoura Medical Journal*: Vol. 35 : Iss. 1 , Article 11.

Available at: <https://doi.org/10.21608/mjmu.2006.128748>

This Original Study is brought to you for free and open access by Mansoura Medical Journal. It has been accepted for inclusion in Mansoura Medical Journal by an authorized editor of Mansoura Medical Journal. For more information, please contact mmj@mans.edu.eg.

AN ANTHROPOMETRIC STUDY ON THE COMPONENT BONES IN EGYPTIAN'S MALE AND FEMALE FOOT

By
Ibrahim Attia Shaaban

From
Anatomy Department, Faculty of medicine, Mansoura University

INTRODUCTION

The distinctive morphology of human foot depends largely on its components of bones. Measurements of these bones are the most important factors in determining the corresponding foot morphology. These measurements vary according to the age, sex, genetic background and race (Tanner, 1976; Naeye and Tafari, 1983; Al-Hazzaa, 1990; Evel-eth and Tanner, 1990; Kennedy, 2000) 28,19,1,7,12.

Literature about the anthropometric parameters of bones of Egyptian's foot are few (Butler et al., 1986; Marz-ke, 1997; Chiari et al., 2002)4,16,6. Thus it was decided to provide an anthropometric measurements for the bones of the Egyptian foot. A comparison between the measurements of the bones of the male and female feet were put forward.

This study may provide a helpful data for forensic diagnosis, anthropologists as well as evaluation of deformity cases of the feet.

MATERIAL AND METHODS

The feet of normal and healthy 15 males and 15 females aged 30-40 years old, from Mansoura University Hospitals were used in this study. The feet with pathological or congenital disorders were excluded.

For each foot, the following was performed :

- a. Drawing the foot for its morphology (Fig. 1).
- b. Taking the following measurements: (Fig. 1)
 - 1) Medial border of the foot, from the tip of the big toe to the medial end of the heel (line 1).
 - 2) Lateral border of the foot, from

MANSOURA MEDICAL JOURNAL

the tip of the little toe to the lateral end of the heel (line 2).

- 3) Frontal line from the tip of the big toe to the tip of the little toe (line 3).
 - 4) Angle (A) between line (1) and line (3) and angle (B) between line (2) and line (3) were measured.
- c. Plane X-Ray for the foot with fully extended toes was done (Swallow and Nayler, 1986)²⁷. Using the metallic millimeter ruler and a sliding caliper, the following measurements for the axial lengths for bones of foot are done for each radio-graphed foot: (Figs 2, 3, 4, 5, 6)
1. The length of phalanges of five toes.
 2. The length of metatarsal bones.
 3. The three cuneiform and navicular bones.
 4. The cuboid bone.

The measurements of the 15 males and 15 females were put in tables and charts.

The mean values were calculated and the results were put in tables and histograms. The significant differences between the means for males and females were analyzed by Levene's test (Brown and Forsythe, 1974)³, then by student's test.

RESULTS

The mean values of data obtained from the different bone components of the feet of 15 males and 15 females were presented in table (1), Charts (1-4) and figs (2-6).

A. Length of phalanges: (tables 1, 2, and charts 1a, b, c)

1- The mean lengths of the *proximal phalanges* of the toes of the *male feet* were as follows :

- 3.21±0.20 cm for the 1st toe
- 2.85±0.14 cm for the 2nd toe
- 2.76±0.22 cm for the 3rd toe
- 2.52±0.22 cm for the 4th toe
- 2.40±0.24 cm for the 5th toe

However the *proximal phalanges* of the toes of the *female feet* as found in table (1) showed the following measurements:

- 2.79±0.10 cm for the 1st toe
- 2.42±0.11 cm for the 2nd toe
- 2.30±0.11 cm for the 3rd toe
- 2.22±0.13 cm for the 4th toe
- 2.06±0.10 cm for the 5th toe

From these data, it was noticed that :

(a) A highly significant difference in the length of the proximal phalanx of male 1st toe and that of the corresponding female foot.

(b) A significant difference between the length of the proximal phalanx of the 1st toe to that of the 5th

toe, of the same foot.

2- *The mean lengths of the middle phalanges of the toes of the male feet showed the following measurements: (tables 1, 2, charts 1, 2, 3)*

1.27±0.05 cm for the 2nd toe

1.26±0.21 cm for the 3rd toe

1.16±0.26 cm for the 4th toe

0.81±0.08 cm for the 5th toe

However, the **middle phalanges** of the toes of the **female feet** showed the following measurements:

1.02±0.18 cm for the 2nd toe

1.00±0.12 cm for the 3rd toe

0.95±0.11 cm for the 4th toe

0.78±0.06 cm for the 5th toe

From the previous data, it was noticed that :

(a) A highly significant difference in the length of the middle phalanx of male 2nd toe and that of the corresponding female foot.

(b) A highly significant difference between the lengths of the middle phalanges of male 3rd and 4th toe and that of the corresponding female foot.

(c) No significant difference in the length of the middle phalanx of male 5th toe and that of the corresponding female foot.

3- *The mean values of the distal phalanx of male feet were as follows: (tables 1, 2 and charts 1, 2, 3)*

2.65±0.20 cm for the 1st toe

1.10±0.12 cm for the 2nd toe

1.00±0.10 cm for the 3rd toe

0.91±0.10 cm for the 4th toe

0.70±0.09 cm for the 5th toe

However, the **female feet** showed the following measurements of the **distal phalanges:**

2.34±0.11 cm for the 1st toe

0.98±0.9 cm for the 2nd toe

0.89±0.07 cm for the 3rd toe

0.82±0.08 cm for the 4th toe

0.50±0.11 cm for the 5th toe

From the previous data, it was noticed that :

(a) A highly significant difference in the length of the distal phalanx of male 1st toe and that of the corresponding female foot.

(b) A significant difference in the length of the distal phalanges of the 1st toe in both male and female feet were characteristically larger than those of other toes.

(c) No significant difference in the length of the distal phalanx of male 2nd, 3rd, and 4th toes and that of the corresponding female foot.

(d) The distal phalanx of the 5th toe is the shortest in both sexes.

B. Total length of toes:

From table (3) and chart (1a,c), the mean measurements of the total length of each toe in **male feet** was

as follow :

5.87 cm for the 1st toe.

5.12 cm for the 2nd toe.

5.02 cm for the 3rd toe.

4.59 cm for the 4th toe.

3.91 cm for the 5th toe.

Also from table (3) and chart (1a,c), the mean measurements of the total length of each toe in **female feet** was as follow:

5.13 cm for the 1st toe.

4.42 cm for the 2nd toe.

4.19 cm for the 3rd toe.

3.99 cm for the 4th toe.

3.34 cm for the 5th toe.

From these data, it was noticed that:

a) The 1st toe is the longest while the 5th toe is the shortest toe in both sexes.

b) The 1st toe in male is nearly twice that of the 5th toe in female.

C. The relation between the length of phalanges and the total length of the corresponding toe:

Theses data were shown in table (4) and charts (2a, b) demonstrated that:

1. *The ratio between the length of the proximal phalanges and the total length of the corresponding toe in male feet were as follows:*

0.55 for the 1st toe.

0.56 for the 2nd toe.

0.55 for the 3rd toe.

0.55 for the 4th toe.

0.61 for the 5th toe.

While the ratio between the length of the proximal phalanges and the total length of the corresponding toe in **female feet** were as follows :

0.54 for the 1st toe.

0.55 for the 2nd toe.

0.54 for the 3rd toe.

0.56 for the 4th toe.

0.62 for the 5th toe.

2. *The ratio between the length of the middle phalanges and the total length of the corresponding toe in male feet were as follows:*

0.25 for the 2nd toe.

0.25 for the 3rd toe.

0.25 for the 4th toe.

0.21 for the 5th toe.

While the ratio between the length of the middle phalanges and the total length of the corresponding toe in **female feet** were as follows:

0.23 for the 2nd toe.

0.23 for the 3rd toe.

0.24 for the 4th toe.

0.23 for the 5th toe.

3. *The ratio between the length of the distal phalanges and the total length of the corresponding toe in male feet were as follows:*

0.45 for the 1st toe.

0.19 for the 2nd toe.

0.20 for the 3rd toe.

0.20 for the 4th toe.

0.18 for the 5th toe.

However, the ratio between the length of the distal phalanges and the total length of the corresponding toe in **female feet** were as follows:

0.46 for the 1st toe.

0.22 for the 2nd toe.

0.21 for the 3rd toe.

0.21 for the 4th toe.

0.15 for the 5th toe.

From the previous data, it was noticed that:

(a) No significant difference in the ratio of the all phalanges to the total length of its corresponding toes in both male and female feet.

(b) The ratio of the distal phalanx to the total length of the 1st toe were nearly equal to the sum ratios of 3rd, 4th and 5th toes in both male and female feet.

D. Lengths of metatarsal bones: (tables 1, 2 and charts 1a, b, c)

The mean lengths of the metatarsal bones of **male feet** showed the following measurements:

6.05±0.11 cm for the 1st metatarsal bone.

7.01±0.19 cm for the 2nd metatarsal bone.

6.83±0.25 cm for the 3rd metatarsal bone.

6.80±0.36 cm for the 4th metatarsal bone.

6.20±0.20 cm for the 5th metatarsal bone.

Also the measurements of metatarsal bones of **female feet** were as follow:

5.80±0.11 cm for the 1st metatarsal bone.

6.55±0.22 cm for the 2nd metatarsal bone.

6.20±0.07 cm for the 3rd metatarsal bone.

6.12±0.09 cm for the 4th metatarsal bone.

5.98±0.4 cm for the 5th metatarsal bone.

From the above data, it was noticed that:

(a) A significant difference in the length of the metatarsal bone of male and that of the corresponding female foot.

(b) It was apparent that the length of the 2nd metatarsal bone of both male and female feet is the longest metatarsal bone.

(c) Also, the 1st and 5th metatarsals are short and the 1st is the shortest in both male and female feet .

(d) The 4th metatarsal bone is smaller than the 3rd in both sex.

E. Relation between the length of metatarsal bones and the total

length of the corresponding toe:

These data were shown in table (5) and charts (3a, b) demonstrated that:

The ratio between the length of metatarsal and the total length of the corresponding toe in **male feet** were as follows:

1.03 for the 1st toe.

1.37 for the 2nd toe.

1.36 for the 3rd toe.

1.49 for the 4th toe.

1.59 for the 5th toe.

While, the ratio between the length of metatarsal and the total length of the corresponding toe in **female feet** were as follows:

1.13 for the 1st toe.

1.48 for the 2nd toe.

1.45 for the 3rd toe.

1.53 for the 4th toe.

1.79 for the 5th toe.

From these mentioned data, it was noticed that:

(a) No significant difference in the ratio between the metatarsal bones and the total length of the corresponding toe of both male and female.

(b) The largest ratio between the metatarsal bone and the total length of the corresponding toe is the 5th toe in both sex.

F. Lengths of the tarsal bones:
Table (1)

1. *The mean measurements of the cuneiform bones were as follows:* Table (1)

(a) **In male feet** were:

2.61±0.33 cm for the medial cuneiform bone

2.03±0.12 cm for the intermediate cuneiform bone

2.45±0.18 cm for the lateral cuneiform bone

(b) **In female feet** were:

2.23±0.18 cm for the medial cuneiform bone

1.85±0.07 cm for the intermediate cuneiform bone

2.08±0.06 cm for the lateral cuneiform bone

From these recorded data, it was noticed that:

(a) The medial cuneiform bone is the biggest and the intermediate one is the smallest in both sex.

(b) The male intermediate cuneiform bone (the smallest) equal to the female lateral cuneiform one.

2. *The mean measurements of the cuboid and navicular bones were as follows:* table (1)

(a) **In male feet** were:

3.19±.19 cm for the cuboid bone

1.30±0.09 cm for the navicular bone

(b) **In female feet** were:

2.67±0.21 cm for the cuboid bone

1.38±0.11 cm for the navicular bone

From these data, it was noticed that:

(a) There was a highly significant difference in measurements of cuboid and significant difference of navicular bones in male feet to the corresponding one in the female feet.

(b) The cuboid bone is larger than the navicular bone (nearly double) in both sex.

G. Measurements of the three lines of the foot :

It was obvious from table (1) and Fig. (1), that the mean measurements of the three lines of feet were as follows:

a) **In male :** Line (1): (from the tip of the big toe to the medial end of heel) was 25.09±1.33 cm.

Line (2): (from the tip of the little toe to the lateral end of heel) was 21.67±0.57 cm.

Line (3): (from the tip of the big toe to the tip of the little toe) was 7.50±0.62 cm .

b) **In female :** Line (1): (from the tip of the big toe to the medial end of heel) was 22.60±0.47 cm .

Line (2): (from the tip of the little toe to the lateral end of heel) was 18.25±0.89 cm.

Line (3): (from the tip of the big toe to the tip of the little toe) was 7.22±0.05 cm .

From these data, it was noticed that :

(a) There was a high significant difference in measurements of line (1) and line (2) in male feet to the corresponding one in the female feet.

(b) These lines are in male longer than that of female's feet.

(c) No significant difference of the line 3 (frontal line) in male feet to that of female one.

H. Measurements of the angles :

It was obvious from table (1), Fig. (1) and chart (4), the mean measurements of the angles were as follows.

Angle (A): between line 1 (from the tip of the big toe to the medial end of heel) and line 3 (from the tip of the big toe to the tip of the little toe) was 55.73±4.22 in male feet and 58.46±4.22 in female ones.

Angle (B) : between line 2 (from the tip of the little toe to the lateral end of heel) and line 3 (from the tip of the big toe to the tip of the little toe) was 118.86±8.17 in male feet and 117.86±8.17 in female ones.

From these data, it was noticed that :

- There was a minimal difference in measurements of angle A in female feet to the corresponding one in the male feet. These angles are greater in female than in the male feet.

- No significant differences between both sexes as regards the angle B.

Table (1): Data of different values of bones of Egyptian's male and female foot

		MALE	FEMALE	Population Mean		t-test P	
		MEAN \pm SD (cm)	MEAN \pm SD (cm)	95% confidence			
PHALANGES				MALE	FEMALE	Significant < 0.01	
1st toe	1P	3.21 \pm 0.2	2.79 \pm 0.1	2.81	2.60	0.000000	**
	1D	2.86 \pm 0.2	2.34 \pm 0.11	2.26	2.13	0.000021	**
2nd toe	2P	2.85 \pm 0.14	2.42 \pm 0.11	2.59	2.20	0.000000	**
	2M	1.27 \pm 0.06	1.02 \pm 0.18	1.18	0.68	0.000622	**
	2D	1.10 \pm 0.12	0.93 \pm 0.09	0.76	0.80	0.375320	
3rd toe	3P	2.76 \pm 0.22	2.30 \pm 0.11	2.32	2.09	0.000000	**
	3M	1.26 \pm 0.21	1.00 \pm 0.12	0.84	0.77	0.000344	**
	3D	1.00 \pm 0.10	0.89 \pm 0.07	0.80	0.75	0.122210	
4th toe	4P	2.52 \pm 0.22	2.22 \pm 0.13	2.09	1.96	0.000154	**
	4M	1.16 \pm 0.28	0.95 \pm 0.11	0.64	0.74	0.006127	**
	4D	0.91 \pm 0.10	0.82 \pm 0.08	0.71	0.67	0.013289	*
5th toe	5P	2.40 \pm 0.24	2.08 \pm 0.10	1.93	1.87	0.130046	
	5M	0.81 \pm 0.03	0.73 \pm 0.06	0.65	0.66	0.181648	
	5D	0.7 \pm 0.09	0.60 \pm 0.11	0.52	0.29	0.000064	**
METATARSALS							
	1st	6.06 \pm 0.11	5.80 \pm 0.11	5.84	5.59	0.000007	**
	2nd	7.01 \pm 0.19	6.55 \pm 0.22	6.63	6.12	0.000018	**
	3rd	6.83 \pm 0.25	6.20 \pm 0.07	6.33	6.07	0.000000	**
	4th	6.80 \pm 0.38	6.12 \pm 0.09	6.14	5.94	0.000001	**
	5th	6.20 \pm 0.20	5.93 \pm 0.04	6.81	5.90	0.000406	**
TARSALS							
Cuneiforms							
	M.	2.61 \pm 0.33	2.23 \pm 0.18	1.96	1.87	0.000682	**
	INT.	2.03 \pm 0.12	1.85 \pm 0.07	1.79	1.71	0.000050	**
	L.	2.45 \pm 0.13	2.03 \pm 0.06	2.09	1.96	0.000000	**
	Nav.	1.30 \pm 0.09	1.33 \pm 0.11	1.12	1.16	0.040713	*
	Cub.	3.19 \pm 0.19	2.67 \pm 0.21	2.81	2.27	0.000002	**
LINES							
	Line (1)	25.09 \pm 1.33	22.60 \pm 0.47	22.49	21.08	0.000000	**
	Line (2)	21.67 \pm 0.57	19.25 \pm 0.89	20.55	16.51	0.000000	**
	Line (3)	7.50 \pm 0.62	7.22 \pm 0.05	6.29	5.36	0.211616	
ANGLES		Degree	Degree				
	Angle (A)'	55.73 \pm 4.22	58.46 \pm 4.22	47.37	50.19	0.373360	
	Angle (B)'	118.86 \pm 8.17	117.86 \pm 8.17	106.05	101.85	0.453420	

SD = Standard Deviation of Sample

Population Mean = Mean Value Estimated for Population

t- test = t value of comparison (Male / Female)

* = Significant

** = Highly Significant

Table (2): The mean value of metatarsals and phalanges (cm)

	METATARSALS		PROXIMAL PH.		MIDDLE PH.		DISTAL PH.	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
1st toe	6.05±0.11	5.80±0.11	3.21	2.79				
2nd toe	7.01±0.19	6.55±0.22	2.85	2.42	1.27	1.02	2.65	2.34
3rd toe	6.83±0.25	6.20±0.07	2.76	2.30	1.26	1.00	0.99	0.98
4th toe	6.80±0.36	6.12±0.09	2.52	2.22	1.16	0.95	1.00	0.89
5th toe	6.20±0.20	5.98±0.04	2.40	2.06	0.81	0.78	0.91	0.82
							0.70	0.50

Table (3): Total length of each toe (cm)

	MALE	FEMALE
1st toe	5.87	5.13
2nd toe	5.12	4.42
3rd toe	5.02	4.19
4th toe	4.59	3.99
5th toe	3.91	3.34

Table (4): Ratio of different phalanges to the length of its corresponding toe

	PROXIMAL PHALANX		MIDDLE PHALANX		DISTAL PHALANX	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
1st toe	0.55	0.54				
2nd toe	0.56	0.55	0.25	0.23	0.45	0.48
3rd toe	0.55	0.56	0.25	0.24	0.19	0.22
4th toe	0.55	0.56	0.25	0.24	0.20	0.21
5th toe	0.61	0.62	0.21	0.23	0.20	0.21
					0.18	0.15

Table (5): Ratio of metatarsals to the length of its corresponding toe

	METATARSALS		Length of each toe		RATIO OF MALE	RATIO OF FEMALE
	MALE	FEMALE	MALE	FEMALE		
1st toe	6.05	5.80	5.87	5.13		
2nd toe	7.01	6.55	5.12	4.42	1.03	1.13
3rd toe	6.83	6.20	5.02	4.28	1.37	1.48
4th toe	6.80	6.12	4.59	3.99	1.36	1.46
5th toe	6.20	5.98	3.91	3.34	1.48	1.53
					1.59	1.79

CHART (1a): THE MEAN VALUE OF DIFFERENT METATARSAL BONES AND PHALANGES (cm)

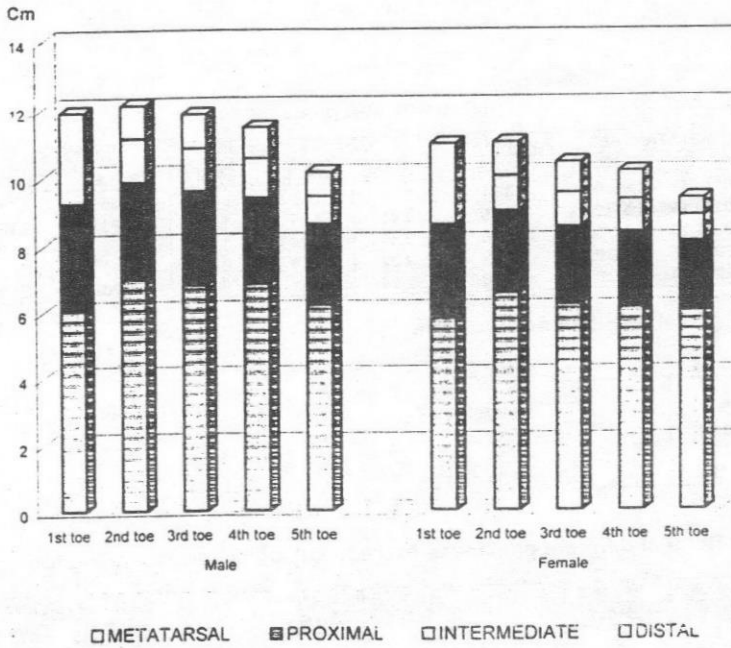


CHART (1b): THE MEAN VALUE OF METATARSAL BONES AND PHALANGES (cm)

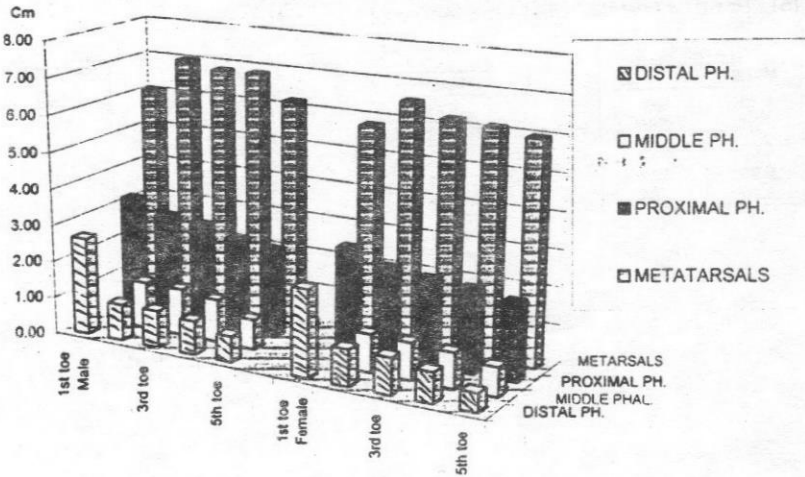


CHART (1C): THE MEAN VALUE OF METATARSAL BONES AND PHALANGES (cm)

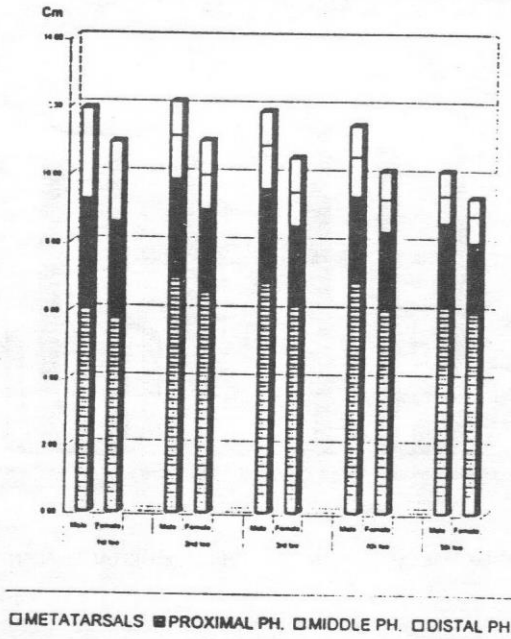


CHART (2a): RATIO OF DIFFERENT PHALANGES TO THE LENGTH OF THE CORRESPONDING TOE

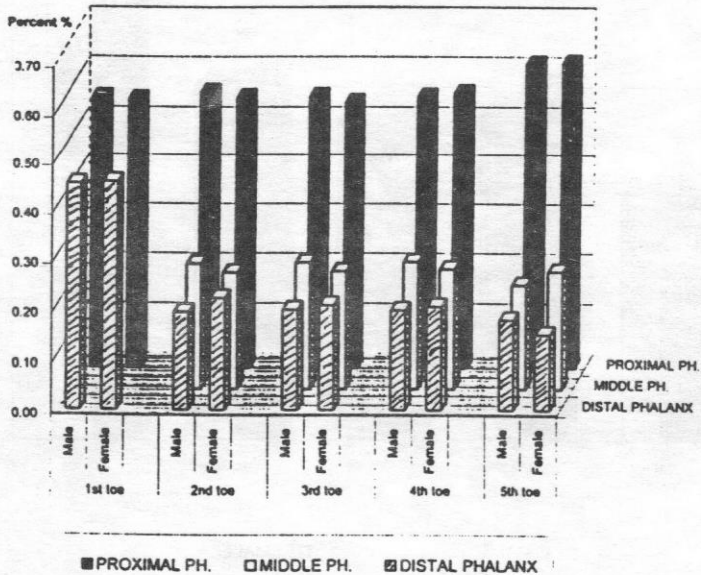


CHART (2b): RATIO OF DIFFERENT PHALANGES TO THE LENGTH OF THE CORRESPONDING TOE

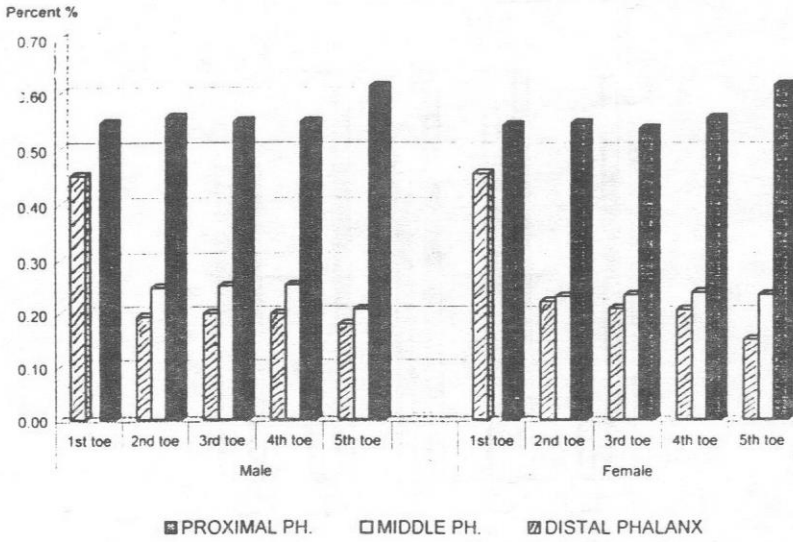


CHART (3a): RATIO OF DIFFERENT METATARSALS TO THE LENGTH OF THE CORRESPONDING TOE

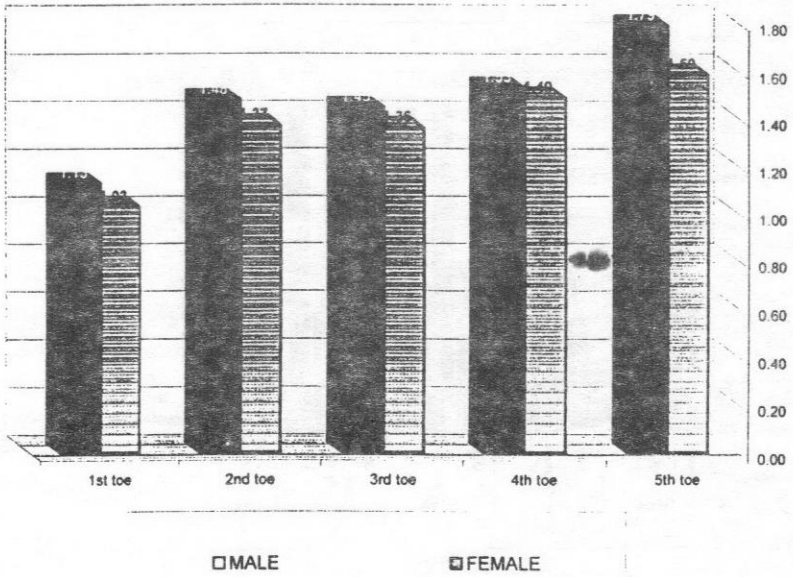


CHART (3b): RATIO OF DIFFERENT METATARSALS TO THE LENGTH OF CORRESPONDING TOE

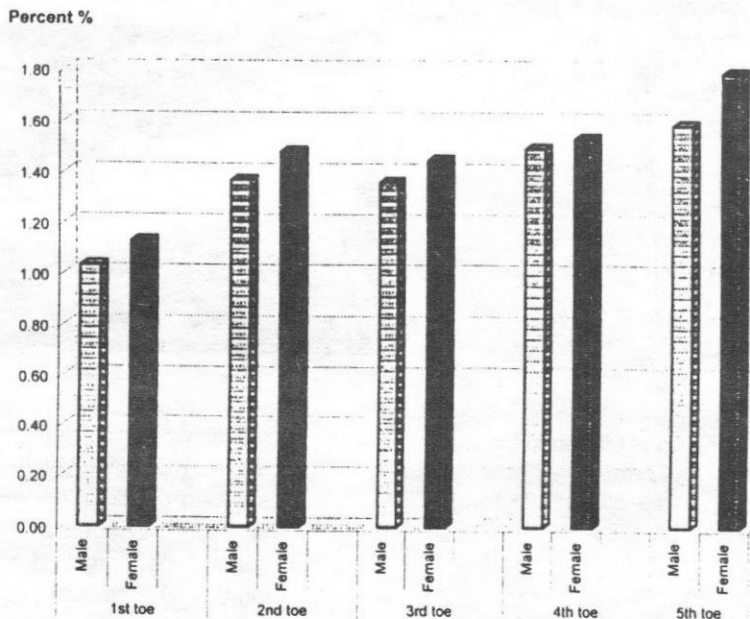
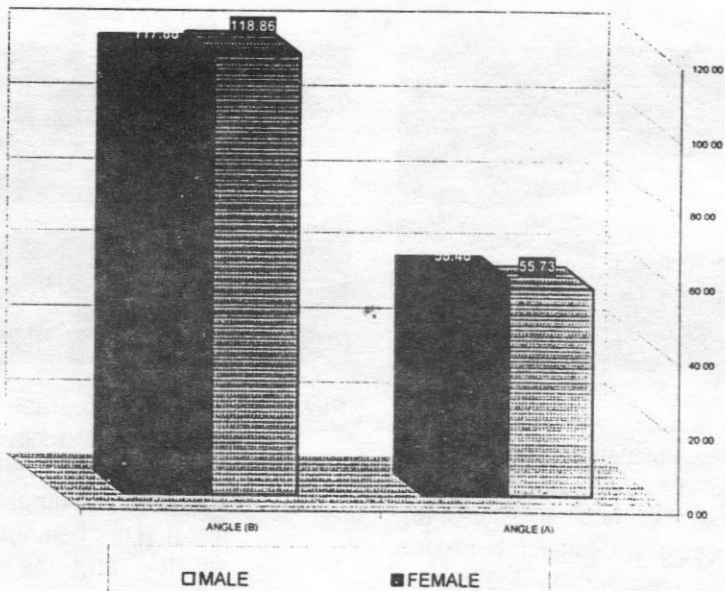


CHART (4): MEASUREMENTS OF ANGLES FOR MALE AND FEMALE FOOT (Degree)



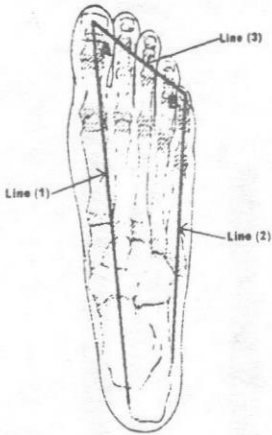


Fig. (1) :

Line (1) : from the tip of big toe to the medial end of heel.

Line (2) : from the tip of the little toe to the lateral end of heel.

Line (3) : from the tip of the big toe to the tip of the little toe.

Angle (A) : between line (1) and line (3).

Angle (B) : between line (2) and line (3).

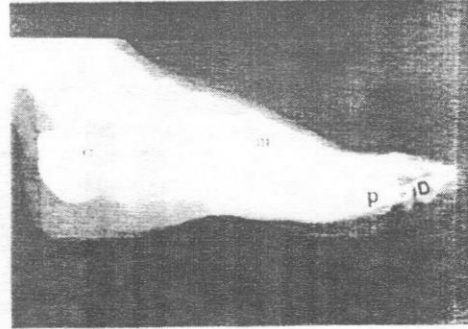


Fig. (2) : A microphotograph for plane X-ray film (medial view) of right adult male Egyptian foot, showing proximal (P) and distal (D) phalanges of the 1st toe, 1st metatarsal (1) and calcaneus (C) bones.

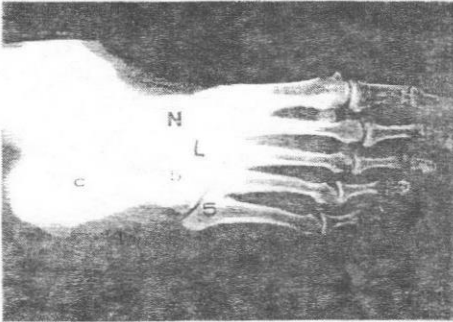


Fig. (3) : A microphotograph for plane X-ray film (lateral view) of right adult male Egyptian foot, showing the 5th metatarsal (5), cuboid (b), lateral cuneiform (L), navicular (N) and calcaneus (C) bones.

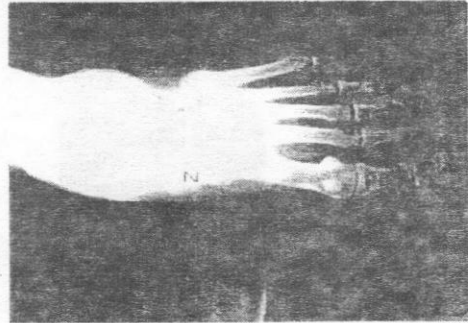


Fig. (4) : A microphotograph for plane X-ray film (PA view) of right adult male Egyptian foot, showing proximal (P) and distal (D) phalanges of the 1st toe and the navicular (N) bones.

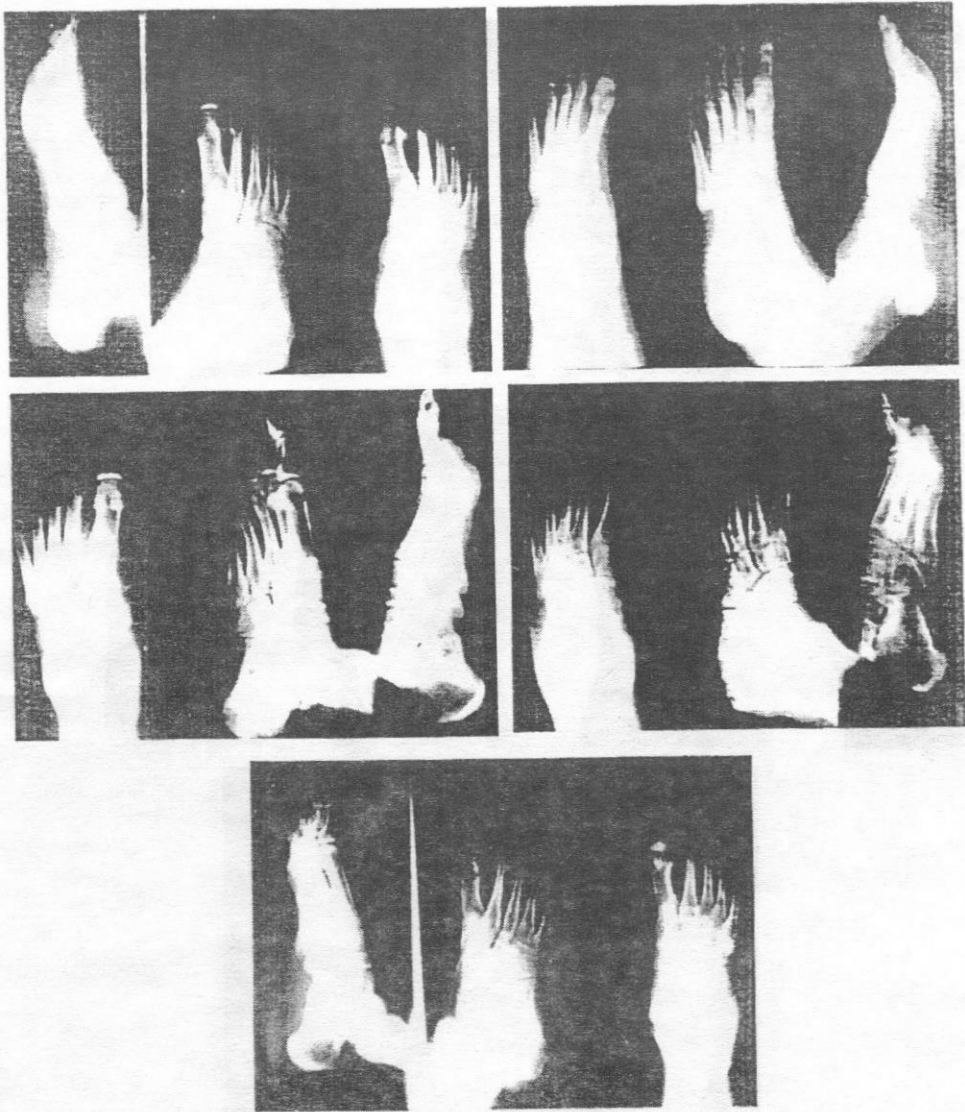


Fig. (5a): MALE (a)

Fig. (5a) : A microphotograph for plane X-ray film (3 views) for 5 adult male Egyptian feet.

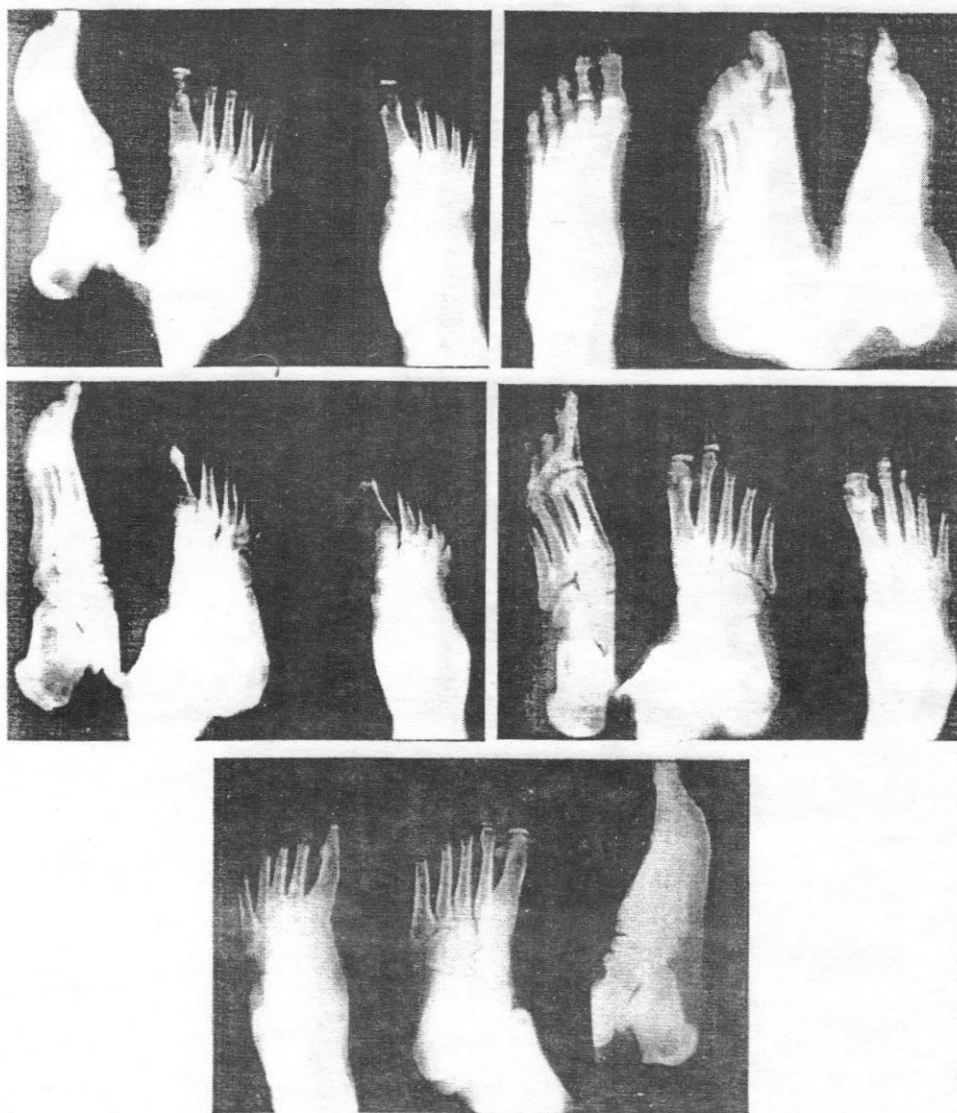


Fig. (5b): MALE (b)

Fig. (5b) : A microphotograph for plane X-ray film (3 views) for 5 adult male Egyptian feet.

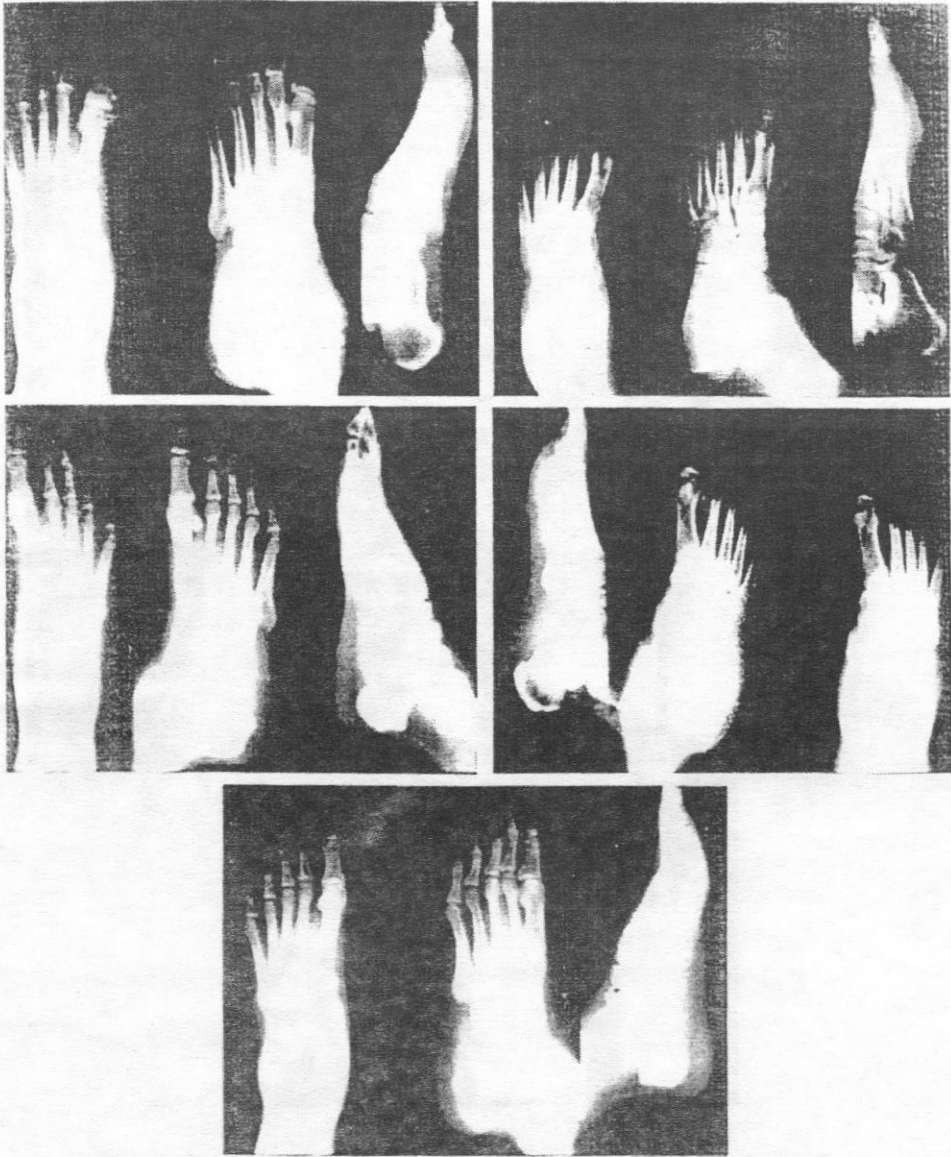
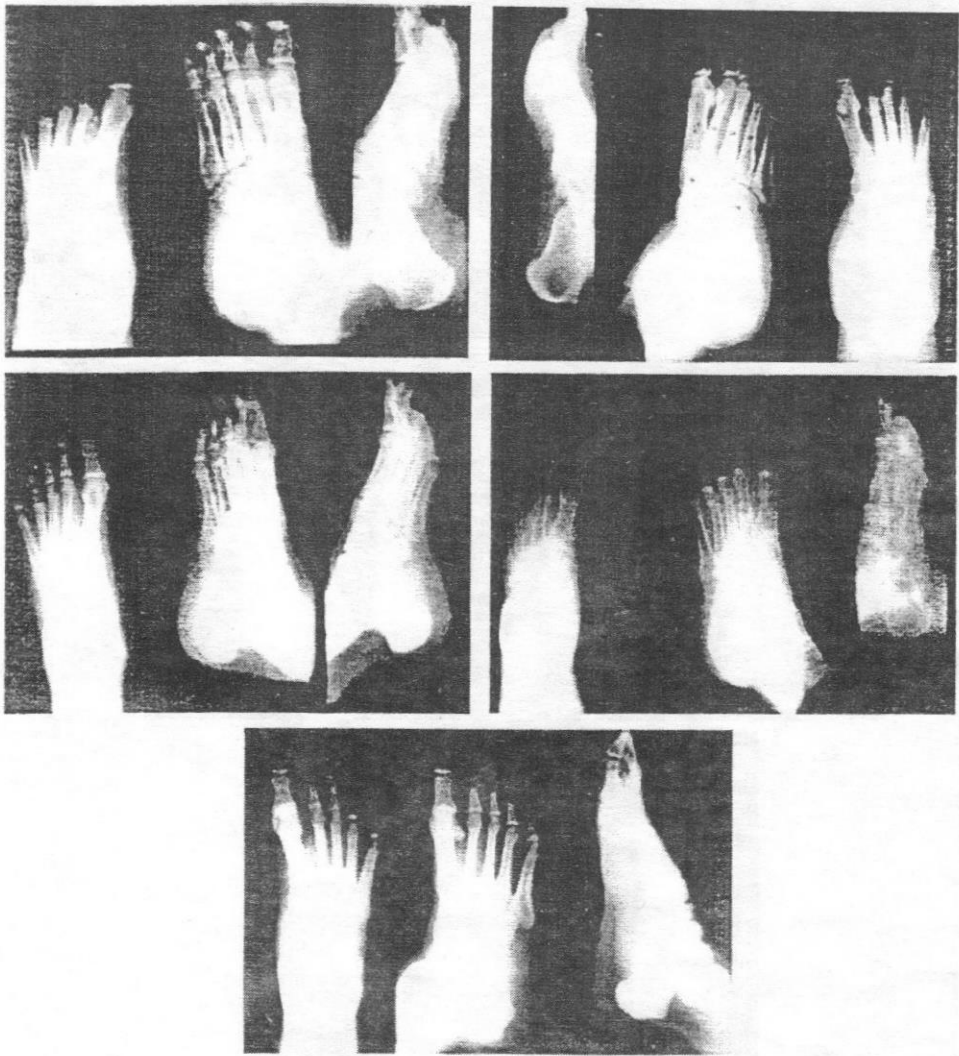


Fig. (5c): MALE (c)

Fig. (5c) : A microphotograph for plane X-ray film (3 views) for 5 adult male Egyptian feet.



Fig(6a):FEMALE (a)

Fig. (6a) : A microphotograph for plane X-ray film (3 views) for 5 adult female Egyptian feet.

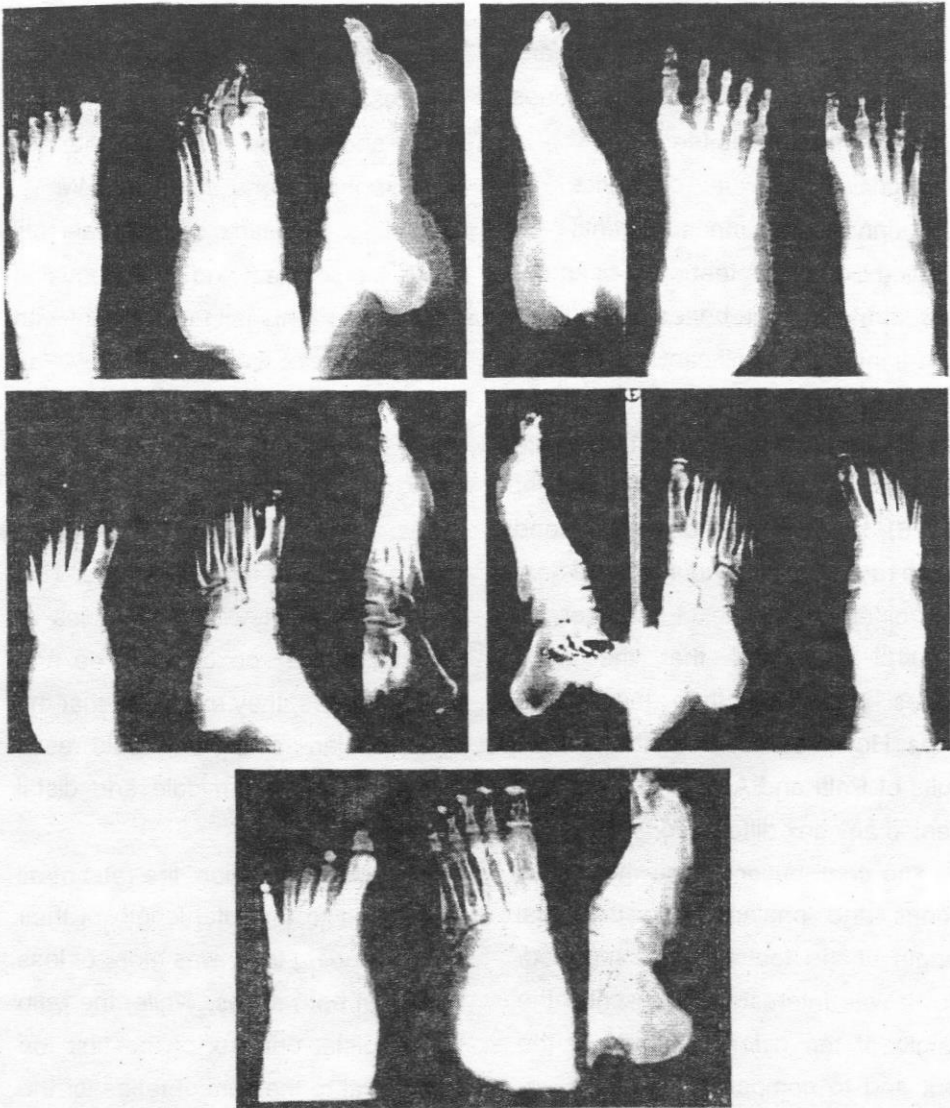


Fig (6b): FEMALE (b)

Fig. (6b) : A microphotograph for plane X-ray film (3 views) for 5 adult female Egyptian feet.

DISCUSSION

In this study, the anthropometric measurements of bones of Egyptians for both sexes verified greater values for male than female feet.

Significant sexual differences of anthropometric measurements of studied Egyptian's feet have been detected. Most of the bones of the male feet showed a significant greater values than those of the corresponding female feet. This is concomitant with studies of Johnston and Beller (1976)¹¹ on composition of black and white races, who found a marked sexual difference. Also, Ferrari et al. (2004)⁸ described that the male bones are larger than the female ones. However, this is contrary to results of Palti and Adler (1975)²⁰ who denied any sex difference.

The contribution of the metatarsal bones and phalanges in the total length of the foot was not reported. So, it was interested to describe the length of the different bones of the foot and to compare their mean anthropometric values.

In the present study, the proximal and distal phalanges of the first toe are the longest in both sexes and longer in male than in female. Also,

the proximal phalanx of the first toe is longer than that of the fifth one. The distal phalanx of the fifth toe is the shortest. The middle phalanx of the male second toe is longer than its corresponding one in female. While, the middle phalanx of the male 5th toe is the smallest and nearly equal in both sexes. This is in agreement with the studies of Lewis (1989)¹⁵ who stated that the middle phalanx is small but the distal phalanx is smaller than other different phalanges. The length of male big toe is twice the length of that of fifth female toe. This is in agreement with the studies of Smith (1995)²⁴ on chimpanzee and human bones, they explained that the distal phalanx of big toe could result from fusion of its middle and distal phalanges.

In this investigation, the ratio of all phalanges to the total length of their corresponding toes, was more or less similar in both sexes. While, the ratio of the distal phalanx of the first toe was equal to the sum of ratios for the 3rd, 4th and 5th toes in both sexes. High ratio of big toe accommodate to a variety of shapes to secure the bones firmly (Smith, 1995).²⁴

The present study illustrated that

the longest toe was for the 1st toe followed by the 2nd, 3rd, 4th and 5th toes. The male 1st toe was nearly twice the 5th toe in female. A similar data was also reported in British people (Hemp, 1964)¹⁰.

As regard the metatarsal bones, it was found that the shortest one was the first, while the longest was the second metatarsal bone. It was also found that the fourth metatarsal bone is shorter than the third one. However, there was a significant differences in the length of the metatarsal bones of male than that of the corresponding female. Consistently, Williams (1995)²⁹ reported that the 1st metatarsal is the shortest, while the 2nd one is the longest.

Moreover, Hemp (1964)¹⁰ and Rightmire et al. (2005)²² found that, the second metatarsal is long and heavy at mid shaft. The differences in lengths of metatarsal bones affect functions of its toes in power and jumping (Peters and Koebke, 1990)²¹.

In this work, it was apparent that the medial cuneiform bone is the longest, while the intermediate cuneiform bone is the smallest in both sexes. The male measurements are

greater than in female. Also, there was significant difference in measurements of the cuboid and navicular bones in male feet to the corresponding female. While, the cuboid bone was nearly double the navicular bone in both sexes. This in agreement with studies of Williams (1995)²⁹ who reported that the Egyptian feet did not differ greatly from different developing nations.

The medial and lateral borders of male foot were bigger than that of female. The measured angles are variable between male and female Egyptian's foot. The medial angle was greater in female than in male. This agreed with the results of Stern and Susman (1983)²⁵ as well as Stern et al. (1995)²⁴ who calculated angle to measure the phalangeal curvature in *A. aferensis* which was more curved than human due to using it in arboreal climbing. The angle measured illuminate the morphological basis of human facility for moving and maintaining against resistance. These variations of angles are due to reciprocal curvature of tarsal and metatarsal surface more in female due to relative flat joints, functions and foot muscles (Athehian et al., 1992; Xu et

al., 1998)^{2,30}. Also, the results agreed with studies of Lewis (1989), Sarmiento (1994) and Marzke et al. (1999)^{15,23,17}, who noticed angles between tarsal joint axis and axes of the joints of basis of African apes and humans. The angles are guide to possible muscle function in the feet. The relative angles between the principle axes of the bones were employed to describe the shape of the foot (Camacho et al., 2002; Kouchi, 2003)^{5,13}.

The obtained data may certain clinical diseases, identify the sex and solve some forensic problems. Also, helps in assessment of foot changes and impaired growth or change of single bone, group of bones in toes, metatarsal, phalanges or segments of foot which might be reduced in size e. g. Bradydactyly, Fanconi and Marfan syndromes (Merlob et al., 1984; Butler et al., 1986)^{18,4}, Down, Turner and Achondroplasia syndromes (Green Field et al., 1967; Landry et al., 1979)^{9,14}.

SUMMARY

This study was carried out on 30 normal mid-aged Egyptian feet, fifteen males and fifteen females, from El-Mansoura University hospitals.

They were subjected to plane X-ray for their feet, then the anthropometric measurements were done and the data tabulated.

The length of big toe, 2nd, 3rd, 4th and 5th toes measurements were: 5.87, 5.12, 5.02, 4.59 and 3.91 cm respectively in male feet and 5.13, 4.42, 4.28, 3.99 and 3.34 cm respectively in female feet. So, the first toe is the biggest and the fifth toe is the smallest. The second metatarsal bone is the longest of metatarsals, while the fifth metatarsal is the shortest. Contribution of metatarsal bone in the total length of its corresponding toe was found to be 1.03, 1.37, 1.36, 1.49 and 1.59 for the 1st, 2nd, 3rd, 4th and 5th toes of male feet respectively and 1.13, 1.48, 1.45, 1.53 and 1.79 for that of the corresponding female feet.

Also, the ratio of proximal phalanx to the total length of each toe was in male: 0.55, 0.56, 0.55, 0.55 and 0.61 and in female was 0.54, 0.55, 0.54, 0.56 and 0.62. While, the middle phalanx to the total length for male was 0.25, 0.25, 0.25, and 0.21 for the 2nd, 3rd, 4th and 5th toes respectively and for female was 0.23,

0.23, 0.24, and 0.23 for corresponding toes respectively. While, the ratio of the distal phalanx to the total length of each toe in male was 0.45, 0.19, 0.20, 0.20 and 0.18, while in female was 0.46, 0.22, 0.21, 0.21 and 0.15 for corresponding toes respectively.

The ratio of the distal phalanx to its total length was nearly equal to the summation of ratio of to length of other four toes. The distal phalanx of the big too is considered the fused middle and distal phalanges. Importance of 3 lines of foot was discussed. It appeared that there were significant differences in various measurements in bones of feet between male and female where the male values were significantly greater than female values.

In comparison with other anthropometric measurements elsewhere, the present study did not show any significantly retarded growth measurement.

REFERENCES

1. Al-Hazzaa, H. M. (1990) : Anthropometric measurments of Saudi-boys aged 6-14
2. Ateshian, G. A.; Rosenwasser, M. P. and Mow, V. C. (1992) : Curvature characteristics and congruence the big toe tarso-metatarsal joint: Differences between male and female joints. J. Biomechanics, 25:591-607.
3. Brown, M. B. and Forsythe, A. B. (1974) : Robust test for the equality of variances. J. Am. Statistical Associa-tion, 69:364-367.
4. Butler, M. G.; Meaney, F. J. and Kaler, S. G. (1986) : Meta-carpophalngeal pattern profile analysis in clinical genetics: an applied anthropometric method. Am. J. Anthrop., 70:195-201.
5. Camacho, D. L.; Ledoux, W. R.; Rohr, E. S.; Sangeorzan, B. J. and Ching, R. P. (2002) : A three-dimensional, anatomically

years. Ann. Hum. Biol., 17 (1):33-40.

- dation for a finite element stimulation and means of quantifying foot-bone position. Rehabil. Res. Dev., 39(3):401-410.
- 6. Chiari, L.; Rocchi, L. and Capello, A. (2002) :** Stabilometric parameters are affected by anthropometry and foot placement. Clinical biomechanics, 17:666-677.
- 7. Eveleth, P. B. and Tanner, J. M. (1990) :** World wide variations in human growth. 2nd ed., Cambridge, Cambridge University Press.
- 8. Ferrari, J.; Davi, A. and Hopkinson, M. D. (2004) :** Size and shape differences between male and female foot bones. J. of American Podiatric medical association, 94(5):434-452.
- 9. Green Field, G. E.; Escamilla, C. H. and Schorsch, H. A. (1967) :** The hand and an indicator of generalized disease. Am. J. Roentgenol., 99:736-745.
- 10. Hemp, L. A. W. (1964) :** "Mathematics for Radiographers". 2nd ed., Oxford-Blackwell Scientific Publications.
- 11. Johnston, F. E. and Beller, A. (1976) :** Anthropometric evaluation of the body composition of black, white and Puerto Rican newborns. Am. J. Clin. Nutr., 29: 61-65.
- 12. Kennedy, R. B. (2000) :** Bare foot print marks. Encyclopedia of forensic sciences, 3:1189-1195.
- 13. Kouchi, M. (2003) :** Inter-generation differences in foot morphology: aging or secular change? J. Human Ergol., 32(1):23-48.
- 14. Landry, D. J.; Vanhoutte, J. J. and Raeside, D. E. (1979) :** The application pattern recognition techniques in analysis of metatarso-phalngeal

- lengths. *Invest. Radiol.*, 14: 288-294.
15. **Lewis, O. J. (1989)** : Functional morphology of the evolving hand and foot. Oxford, Clarendon press.
16. **Marzke, M. W. (1997)** : Percision grips, hand morphology and tools. *Am. J. of Physiol. Anthropol.*, 102:91-110.
17. **Marzke, M. W.; Marzke, R. F.; Linscheid, R. L.; Smutz, P.; Steinberg, B. and Reeces, S. (1999)** : Chimpanzee muscle cross sections, moment arms and potential torques and comparisons with humans. *Am. J. Physiol. Anthropol.*, 110 : 163-178.
18. **Merlob, P.; Sivan, Y. and Reisner, S. H. (1984)** : Lower limb standards in new borns. *Am. J. Dis. Child.*, 138:140-142.
19. **Naeye, R. L. and Tafari, N. (1983)** : Risk factors in pregnancy and diseases of fetus and newborn. Baltimore: Williams and Wilkins.
20. **Palti, H. and Alder, B. (1975)** : Anthropometric measurements of new born, sex differences and correlation between measurements. *Hum. Biol.*, 47(4):523-530.
21. **Peters, V. D. and Koebke, J. (1990)** : Torsion der metatarsalia II. *Handchirurgie, Plastische Chirurgie*, 22:191-195.
22. **Rightmire, G. P.; Deacon, H. J. and Tattersall, I. (2005)** : Human foot bones from Klasies River main site, South Africa. *J. Human Evol.*, 18:25-30.
23. **Sarmiento, E. E. (1994)** : Terrestrial triats in hands and feet of gorillas. *American museum Novitates*, 3091:1-56.
24. **Smith, S. L. (1995)** : Pattern profile analysis of hominid and Chimpanzee bones. *Am. J.*

Physiol. Anthropol., 96:283-300.

25. **Stern, J. T. and Susman, R. L. (1983)** : The locomotor anatomy of Australopithecus afarensis. Am. J. of physiol., 60:279-317.
26. **Stern, J.; Jungers, W. L. and Susman, R. L. (1995)** : Quantifying phalangeal curvature: an empirical comparison of alternative methods. American J. of Physical anthropology, 97:1-10.
27. **Swallow, R. A. and Nayler, E. (1986)** : "Clark's positioning in Radiology". 11th ed., William Heinemann Medical books LTD., London.
28. **Tanner, J. M. (1976)** : Population differences in body size, shape and growth rate., Arch. Dis. Child., 51:170-179.
29. **Williams, P. L. (1995)** : Gray's Anatomy. Anatomical basis of medicine and surgery., P.712-736.
30. **Xu, L. F.; Stauch, R. J.; Ateshian, G. A.; Pawluk, R. J.; Mow, V. C. and Rosenwasser, M. P. (1998)** : Topography of osteoarthritic thumb carpometacarpal joint and its variations with regard to gender, age, site and osteoarthritic stage. J. of hand surgery.,23(A): 454-464.

الملخص العربي دراسة أنثروبومترية لمكونات عظام قدم المصريين من الذكور والإناث

د. إبراهيم عطية شعبان

قسم التشريح - كلية الطب - جامعة المنصورة

أجريت هذه الدراسة على أقدام ثلاثين مصرياً متوسطى العمر (١٥ من الذكور، ١٥ من الإناث) من المترددين على مستشفيات جامعة المنصورة. تم عمل أشعة لأقدامهم وأجريت عليها دراسة أنثروبومترية ووضعت فى جداول ورسومات بيانية.

وأوضحت القياسات أن متوسط أطوال أصابع القدم من الأول، الثانى، الثالث، الرابع، والخامس فى أقدام الذكور هى: ٥٨٧، ٥١٢، ٢، ٥، ٣٩١ سم على التوالى، بينما كانت فى الإناث على التوالى أيضاً كالتى: ٥١٣، ٤٤٢، ٤٢٨، ٣٩٩، ٣٣٤ سم وبناء عليه كان الإصبع الأول هو الأكبر وكان الخامس هو الأصغر فى كلا الجنسين. كما كان مشط الأصبع الثانى هو أكبرهم بينما كان الخامس أصغر أمشاط القدم. ولقد وجد أن النسبة بين طول عظام أمشاط القدم لطول كل إصبع لها (من الأول إلى الخامس) كالتى: ١٠٣، ١٣٧، ١٣٦، ١٤٧، ١٥٩ على التوالى فى الذكور. بينما كانت فى الإناث: ١١٣، ١٤٨، ١٤٥، ١٥٣، ١٧٩ على التوالى. وكانت نسبة السلاميات القريبة إلى الطول الأجمالى لكل إصبع لها على التوالى كالتى: ٥٥، ٥٥، ٥٥، ٦١، فى الذكور بينما كانت فى الإناث: ٥٥، ٥٥، ٥٤، ٥٦، ٦٢، أما نسبة السلامية الوسطى لكل إصبع لها فكانت للأصابع من الثانى إلى الخامس كالتى: ٢٥، ٢٥، ٢٥، ٢١، فى الذكور، وكانت: ٢٣، ٢٣، ٢٤، ٢٣، فى الإناث. أما نسبة السلاميات البعيدة إلى كل إصبع من الأول للخامس فكانت على الترتيب كالتى: ٤٥، ١٩، ٢٠، ٢٠، ١٨، فى الذكور وكانت: ٤٦، ٢٢، ٢١، ٢١، ١٥، فى الإناث. وظهر أيضاً أن نسبة السلامية البعيدة للإصبع الأول إلى طوله كانت تساوى تقريباً مجموع نسب الأصابع الأربعة الأخرى ومنه يعتبر أن السلامية البعيدة للإصبع الكبير هى التحام السلامية الوسطى والبعيدة.

ومن ثم يتضح وجود فارق ذو دلالة فى مقاييس عظام القدم بين الذكور والإناث وكانت القيمة كبيرة الدلالة فى الذكور عن الإناث. ولذلك مقارنة بأى دراسات أنثروبومترية أخرى فى أى مكان لم يكن هناك أى أعاقه لأطوال المقاييس المصرية.

